PATENT
Atty. Docket No. DPL-051

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPELLANTS:	Tudryn et al.	CONF. NUMBER:	4071
SERIAL NUMBER:	10/677,087	GROUP NUMBER:	1791
FILING DATE:	October 1, 2003	EXAMINER:	Lazorcik, J. L.
TITLE:	ANODIC BONDING OF SILICON CARBIDE ON GLASS		

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BRIEF ON APPEAL

This Appeal Brief is submitted in accordance with 37 C.F.R. § 41.37 and pursuant to the Notice of Appeal filed on March 11, 2010, in support of the appeal from the final rejection of claims 1, 3, 5-17, 19, 20, and 24 in the above-identified application.

Appellants herewith transmit authorization to pay the fee for filing of this Appeal Brief along with a three month extension-of-time. Appellants believe that no additional fee is required at this time. However, please consider this conditional authorization to charge any related extension fees or other fees necessary for entry and consideration of this Brief to the undersigned counsel's deposit account number 07-1700 with reference to docket number DPL-051.

REAL PARTY IN INTEREST

This application is assigned to The Charles Stark Draper Laboratory, Inc. The assignment was recorded at Reel 015055, Frame 0547, on March 10, 2004. Accordingly, the real party in interest is The Charles Stark Draper Laboratory, Inc.

RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences pending in the above-identified application that will directly affect or will be directly affected by the Board's decision in the present appeal.

STATUS OF CLAIMS

The application as filed contained 17 claims, and in an amendment filed on January 18, 2007, Appellants amended claims 1-3, 6-7, and 12-17 and added new claim 18. In an amendment filed on October 4, 2007, Appellants added new claims 19-21 and cancelled claim 18. In an amendment filed on June 17, 2008, Appellants amended claims 1, 3, 12, and 17 and cancelled claims 2 and 21. In an amendment filed on January 12, 2009, Appellants amended claims 1 and 17 and added new claims 22 and 23. In an amendment filed on August 17, 2009, Appellants amended claims 1, 9, and 17, added new claim 24, and cancelled claims 4, 22, and 23. Claims 1, 3, 5-17, 19, 20, and 24 are currently pending. All of the pending claims have been rejected and are the subject of this appeal.

STATUS OF AMENDMENTS

No amendments have been filed subsequent to the Office Action mailed on December 11, 2009.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention addresses problems related to methods of bonding different layers of devices and packaging for microelectronic and MEMS applications.[1] The invention provides for lower bonding temperatures, permits the use of varied materials, and supports simpler processing than in prior art methods.[2] Importantly, the invention allows for the anodic bonding of a glass layer to a polycrystalline layer (such as SiC) having a large elastic modulus and a surface roughness greater than that of a polished wafer.[3] The polycrystalline material and the bonding temperature can be well suited to applications such as microelectronic and MEMS device fabrication.[4] The surface roughness of the polycrystalline material can be much greater than that of a polished single-crystal wafer yet may be less than that of polycrystalline silicon in some prior processes (i.e., less than approximately 1.0 μm).[5]

In one aspect, and as recited in claim 1, a method of anodic bonding at least a portion of a MEMS device includes providing a first layer comprising a glass and a first substrate comprising a polycrystalline material having an elastic modulus greater than about 300 gigaPascals, and causing a first surface of the first substrate to have an RMS surface roughness of greater than 0.001 μm and less than about 0.2 μm.[6] The method further includes directly contacting the first surface of the first substrate to a surface of the first layer, and applying a voltage between the first layer and the first substrate, through electrical contacts in direct contact with each of the first layer and the material having an elastic modulus greater than about 300 gigaPascals, to cause an effective anodic bond to form directly between the first layer and the first substrate.[7] Dependent claims 3, 5-15, 19, and 20 depend, either directly or indirectly, from independent claim 1, and contain further limitations to independent claim 1. Claim 16 recites a device having a first layer and a first substrate bonded by the method of claim 1.

---

[1] Specification at ¶[0001] and [0009] (references are to the application as published).
[2] Specification at ¶[0009].
[3] Specification at ¶[0009].
[4] Specification at ¶[0009].
[5] Specification at ¶[0009].
[6] Specification at ¶[0009]-[0014], [0035]-[0037], and FIG. 2A.
[7] Specification at ¶[0009]-[0014], [0025], [0035]-[0037], and FIG. 2A.

In another aspect, and as recited in claim 17, a method for packaging a MEMS component includes providing a MEMS component comprising a glass layer having a surface and consisting essentially of at least one of a borosilicate glass and an aluminosilicate glass and providing a device package comprising a material having an elastic modulus greater than about 300 gigaPascals,[8] formed from polycrystalline silicon carbide[9] and having a first surface with an RMS surface roughness of greater than 0.001 μm and less than about 0.2μm.[10] The method further includes contacting the first surface of the package to the surface of the glass layer and causing the first surface of the package and the glass layer to have a temperature value that does not exceed about 350 °C while applying a voltage to form an effective bond between the MEMS component and the package.[11] The voltage is applied between the glass layer and the package through electrical contacts in direct contact with each of the glass layer,[12] and the material has an elastic modulus greater than about 300 gigaPascals.[13]

In yet another aspect, and as recited in claim 24, a method for anodic bonding at least a portion of a MEMS device includes providing a first layer comprising a glass, providing a first substrate comprising a material having an elastic modulus greater than about 300 gigaPascals,[14] and causing a first surface of the first substrate to have an RMS surface roughness of greater than 0.001 μm and less than about 0.2 μm.[15] The method further includes directly contacting the first surface of the first substrate to a surface of the first layer, and causing the first layer and the first substrate to have a temperature that does not exceed about 350 °C[16] while applying a voltage between the first layer and the first substrate.[17] The voltage is applied through electrical contacts in direct contact with each of the first layer to cause an effective anodic bond to form directly between the first layer and the first substrate.[18] The material has an elastic modulus greater than about 300 gigaPascals.[19]

---

[8] Specification at ¶[0009]-[0014], [0019], [0035]-[0041], and FIG. 2A.
[9] Specification at ¶[0009]-[0010], [0014], [0035]-[0037], and FIG. 2A.
[10] Specification at ¶[0011].
[11] Specification at ¶[0009]-[0014], [0019], [0035]-[0041], and FIG. 2A.
[12] Specification at ¶[0009]-[0014], [0025], [0035]-[0037], and FIG. 2A.
[13] Specification at ¶[0009]-[0010], [0014], [0035]-[0037], and FIG. 2A.
[14] Specification at ¶[0009]-[0014], [0035]-[0037], and FIG. 2A.
[15] Specification at ¶[0011].

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issues on appeal are whether claim 17 is unpatentable under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement; whether claims 1, 3, 10, 16, 19, and 20 under 35 U.S.C. §103(a) are unpatentable over U.S. Patent No. 5,877,070 to Goesele *et al.* (hereinafter "Goesele") in view of Lee et al. (Electrochemical Society Proceedings, Volume 97-36; Semiconductor Wafer Bonding: Science, Technology, and Applications IV, (1998) pp. 200-204) (hereinafter "Lee I"); whether claims 5-7, 11, 17, and 24 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Berthold *et al.* (Sensors and Actuators 82, 224-228, (2000)) (hereinafter "Berthold") in view of International Application No. PCT/JP03/00570 to Fukushima *et al.* (hereinafter "Fukushima"); whether claims 8-9 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Fukushima; whether claim 12 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Cozma et al. (J. Miromech. Microeng. 5 (1995) 98-102), (hereinafter "Cozma"), Lee *et al.* (Sensors and Actuators 86(2000) 103-107) (hereinafter "Lee II"), and the ordinary level of skill in the art at the time of the invention; and whether claims 13, 14, and 15 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of

---

[16] Specification at ¶[0009]-[0014], [0019], [0035]-[0041], and FIG. 2A.
[17] Specification at ¶[0009]-[0014], [0019], [0035]-[0041], and FIG. 2A.
[18] Specification at ¶[0009]-[0014], [0019], [0035]-[0041], and FIG. 2A.
[19] Specification at ¶[0009]-[0010], [0014], [0035]-[0037], and FIG. 2A.

Lee I and further in view of the combined teachings of U.S. Patent No. 6,550,337 to Wagner *et al.* (hereinafter "Wagner"), Sarro (Sensors and Actuators A: Physical, 82(1), pp. 210-218, (2000)) (hereinafter "Sarro"), Schmidt (Proceedings of the IEEE, 86(6), 1575-1585, (1998)) (hereinafter "Schmidt"), and Lee *et al.* (J. Vac. Sci. Tech. B 12(6), 3425-3430, (1994)) (hereinafter "Lee III").

ARGUMENT

I. Claim 17 is patentable under 35 U.S.C. §112, first paragraph

Independent claim 17 recites a method of packaging a MEMS component in which "*the voltage is applied between the glass layer and the package through electrical contacts in direct contact with each of the glass layer and the material having an elastic modulus greater than about 300 gigaPascals.*" The Examiner incorrectly alleges[20] that the specification as originally filed provides substantially no support for the recited step.

It is well established that exact terms from the specification need not be used *in haec verba* to satisfy the written description requirement of the first paragraph of 35 U.S.C. §112.[21] Instead, substantial correspondence between the language of the claims and the language of the specification is sufficient.[22] Furthermore, possession of an invention may be demonstrated by disclosure of drawings that are sufficiently detailed to show that Applicant was in possession of the claimed invention as a whole. In fact, drawings alone may provide a 'written description' of an invention as required by §112.[23]

Appellants respectfully submit that the specification conveys to one skilled in the art that a voltage can be applied between the glass layer and the package through electrical contacts in direct contact with each of the glass layer and the material having an elastic modulus greater than about 300 gigaPascals. For instance, the specification states that "*[t]he glass layer 310 may be bonded to the substrate 320 via, for example, the method 100*,"[24] with an exemplary embodiment of this method set forth in the specification and drawings as originally filed.[25] For example, FIG. 2A of the application as filed, which illustrates an embodiment of the anodic bonding method 100,[26] clearly depicts a glass layer (210) and a polycrystalline SiC layer (220) being bonded to through electrical contacts in direct contact with each of the glass layer and the polycrystalline SiC layer.

---

[20] Office action of December 11, 2009 at page 2.

[21] *Eiselstein v. Frank*, 52 F.3d 1035, 1038, 34 USPQ2d 1467, 1470 (Fed. Cir. 1995) and *In re Wertheim*, 541 F.2d 257, 265, 191 USPQ 90, 98 (CCPA 1976); MPEP §1302.01.

[22] 37 CFR §1.121(e).

[23] *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1565, 19 USPQ2d 1111, 1118 (CAFC 1991); MPEP §2163.

Accordingly, Appellants respectfully submit that the Examiner's rejection of claim 17 under 35 U.S.C. §112, first paragraph is clearly erroneous.

II. Claims 1, 3, 10, 16, 19, and 20 are patentable under 35 U.S.C. §103(a) over Goesele in view of Lee I

The burden is on the Examiner to demonstrate that each feature of a claim is met by a reference or valid combination of references. The courts have repeatedly and consistently held that "all limitations [of a claim] must be considered ... and it is error to ignore specific limitations in distinguishing over the references."[27] Regarding independent claim 1, the Examiner fails to demonstrate that the cited art teaches every limitation of the claim.

Appellants' independent claim 1 requires applying a voltage between the first layer and the first substrate "*through electrical contacts in direct contact with each of the first layer and the material having an elastic modulus greater than about 300 gigaPascals*." The Examiner incorrectly interprets Goesele as disclosing application of a voltage between the first layer and the first substrate through electrical contacts in direct contact with each of the first layer and the material having an elastic modulus greater than about 300 gigaPascals.[28]

---

[24] Specification at ¶[0038].
[25] Specification at ¶[0035]-[0037] and FIG. 2A.
[26] Specification at ¶[0035].
[27] *In re Boe and Duke*, 184 USPQ 38, 40 (CCPA 1974).

The Examiner fails to provide any evidentiary support for the contention that the anodic bonding of Goesele is performed through electrical contacts in direct contact with each of the first layer and a material layer having an elastic modulus greater than about 300 gigaPascals.[29] While Goesele appears to teach anodically bonding hydrogen implanted silicon carbide to a high temperature glass with a similar coefficient of thermal expansion at a temperature of 560°C,[30] Goesele does not disclose any details regarding the anodic bonding, and is utterly silent on any arrangement of material layers and electrical contacts when performing the anodic bonding step. Similarly, Lee I is silent on the arrangement of material layers and electrical contacts for anodic bonding.

The Examiner alleges that one having a routine level of skill in the art of anodic bonding would have found it obvious to perform the disclosed anodic bonding process through direct electrical contacts.[31] In support of this contention, the Examiner points to "the figure 1 excerpt presented on Page 6 of the Official Office Action dated March 16, 2009."[32] This figure corresponds to Fig. 1 of Berthold,[33] which teaches depositing a thin film of, for example, silicon carbide on a first glass wafer to assist in the bonding of that glass wafer to a second glass wafer. In operation, the bonding described and shown in Berthold[34] is carried out by applying electrical contacts to the first and second glass wafers with the deposited silicon carbide layer sandwiched therebetween. As a result, there is no electrical contact "*in direct contact with … the material*

---

[28] Office action of December 11, 2009 at pages 3-4.
[29] It is never appropriate to rely solely on common knowledge in the art without evidentiary support in the record as the principal evidence upon which a rejection was based.
[30] Goesele at column 12, lines 12-15.
[31] Office action of December 11, 2009 at page 4.
[32] Office action of December 11, 2009 at page 4 & Office Action of March 16, 2009 at page 6.
[33] Berthold at p.225, column 1, "Fig. 1: Anodic bonding set-up"
[34] Id.

having an elastic modulus greater than about 300 gigaPascals," as required by Appellants' independent claim 1. In fact, as Berthold's thin film of silicon carbide is necessarily sandwiched between two glass layers to assist in the bonding of those two layers, electrical contacts cannot directly contact the thin film of silicon carbide during bonding.

As such, not only does the art upon which the Examiner relies fail to teach or suggest a critical claim limitation — i.e., that a voltage be applied between the first layer and the first substrate "*through electrical contacts in direct contact with … the material having an elastic modulus greater than about 300 gigaPascals*" — but in fact, Fig. 1 of Berthold teaches directly away from this claim limitation by relying on a configuration utterly incompatible therewith. The Examiner's rejection of claim 1 is therefore clearly erroneous.

III. Claims 5-7, 11, 17, and 24 under 35 U.S.C. §103(a) are patentable over Goesele in view of Lee I, Berthold, and Fukushima

a. Goesele, Lee I, Berthold, and Fukushima, Alone or in Proper Combination, Fail to Disclose Key Features of Independent Claims 17 and 24

Appellants' independent claims 17 and 24 each require use of electrical contacts that are *in direct contact with* the layers to be bonded, and further require a material having an elastic modulus greater than about 300 gigaPascals.

As described above, Goesele and Lee I fail to teach or suggest any arrangement of material layers and electrical contacts for anodic bonding, while Berthold teaches applying electrical contacts to two glass wafers with silicon carbide sandwiched therebetween — i.e., precluding direct contact with the silicon carbide. Similarly, Fukushima requires placement of the glass plate and cylindrical body to be bonded between an upper and lower sealing jig, with the voltage applied through elements in contact only with the upper and lower sealing jig elements and not in direct contact with the materials to be bonded.[35] Accordingly, both Berthold and Fukushima appear to teach directly away from placing an electrical contact "*in direct contact with ... the material having an elastic modulus greater than about 300 gigaPascals.*"

Appellants' independent claims 17 and 24 further require that the temperature not exceed about 350 °C while the voltage is applied. In direct contrast, both Goesele and Lee I teach anodic bonding at a temperature of at least **560°C**.[36]

Berthold and Fukushima cannot cure the deficiencies of Goesele and Lee I with respect to Appellants' independent claims 17 and 24. Berthold, for example, teaches a method of glass-to-glass anodic bonding using an intermediate film, the bonding temperature "not exceeding 400°C."[37] Although Berthold does state that lower temperatures and voltages had been experimented with and that "high-quality bonding is obtained for many of the other combinations presented here,"[38] nowhere is a temperature lower than 400°C disclosed, and moreover, each of the deposition parameters recited in the presented combination require a bonding temperature of 400°C or more[39] — substantially in excess of the claimed upper maximum of 350°C.

Fukushima teaches a method of anodically bonding a glass plate to a cylindrical body consisting of "a metal consisting of at least one of Fe, Ni and Co or an alloy or conductive ceramics mainly composed of this metal,"[40] with a bonding temperature between "300°C and 500°C."[41] As is known in the art, the elastic modulus of iron (Fe) is about 211 gigaPascals, the elastic modulus of nickel (Ni) is about 200 gigaPascals, and the elastic modulus of cobalt (Co) is about 209 gigaPascals. As such, Fukushima fails to teach or suggest any method of anodically bonding a polycrystalline material having an elastic modulus greater than about 300 gigaPascals as recited in claims 17 and 24. Rather, the methods of Fukushima are directed toward anodically bonding materials having significantly different structural properties from those claimed in the present application. It is well settled that in using a reference for a rejection under 35 U.S.C. § 103(a), the disclosure of the reference cannot be read in such a way that the operative principle of the reference is changed.[42] Appellants respectfully submit that the teachings of Fukushima, which is specifically directed to the anodic bonding of materials having significantly different structural properties from those claimed (i.e., materials having an elastic modulus significantly less than about 300 gigaPascals), cannot properly be combined with Goesele, Lee I, and Berthold so as to fulfill the requirements of independent claims 17 and 24.

---

[35] Fukushima at pages 13-14 and 16, and FIGS. 7 and 10.
[36] Goesele at column 12, lines 12-15 and Lee I at page 203, "Process Considerations" section.
[37] Berthold at page 224, "Introduction" section. [Emphasis added]
[38] Berthold at page 225, bottom of column 1 to top of column 2. [Emphasis Added]
[39] Berthold at page 225, Table 1, and page 226, Table 2.
[40] Fukushima at page 4, lines 24-25.
[41] Fukushima at page 9, lines 6-7.

b. The Cited Art Teaches Directly Away From Any Modification Necessary to Meet Key Limitations of Appellants Claims

For the reasons that follow, Appellants submit that it would not be obvious to one skilled in the art to modify the teachings of Goesele and Lee I (which require a bonding temperature of 560°C) with the teachings of Berthold and Fukushima (which recite bonding various materials at temperatures below 560°C) to arrive at Appellants invention as set forth in independent claims 17 and 24.

Lee I states that "bonding began at 560°C," and that an "effective annealing schedule was designed to prevent the debonding from occurring by decreasing the temperature difference, between the bonding and splitting treatments."[43] Lee I further states that to avoid a large ΔT, "the bonded pair should be continuously heated to the splitting temperature (725°C) from the bonding temperature (560°C) without a cooling down process."[44] Similarly, Goesele states that

---

[42] *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); MPEP § 2143.01(VI).

[43] Lee I at page 302, "Process Considerations" section. [Emphasis added}

[44] Lee I at page 302, "Process Considerations" section.

"[t]he hydrogen implanted silicon carbide was then anodically bonded to a high temperature glass with a similar coefficient of thermal expansion at a temperature of 560 degrees centigrade," and that subsequently "the bonded structure was heat treated at 725 degrees centigrade."[45]

By their own terms, neither Goesele nor Lee I teaches or suggests anodic bonding of a material having an elastic modulus greater than about 300 gigaPascals at anything less than 560°C, and indeed, Goesele and Lee I advocate higher temperatures (i.e., 725°C) for the subsequent transfer of material. The effectiveness of the described methods is improved by reducing the temperature difference between bonding and splitting treatments. Modifying the methods of Goesele and Lee I by reducing the bonding temperature to anything less than 560°C would increase the temperature difference between bonding and splitting treatments, thereby increasing debonding between layers and reducing the effectiveness of the described methods. Accordingly, the departure from the references' actual teaching required to meet the present claim limitations is antithetical to that teaching. Modifying the methods of Goesele and Lee I by reducing the bonding temperature to anything less than 560°C would render the methods of Goesele and Lee I significantly less satisfactory for their intended purpose. It is well-settled that such modifications are improper and cannot support a rejection.[46]

c. Goesele, Lee I, Berthold, and Fukushima, Alone or in Proper Combination, Fail to Disclose Key Features of dependent Claims 5-7 and 11

Appellants' dependent claims 5-7 and 11 depend from independent claim 1, which Appellants respectfully submit are patentable in light of the discussions hereinabove. Appellants' dependent claim 7 further recites "*causing the first layer and the first substrate to have a temperature that does not exceed about 350 °C while applying the voltage*." As discussed hereinabove for independent claims 17 and 24, the cited references, alone or in proper combination, fail to teach or suggest anodically bonding a glass layer to a first substrate comprising a polycrystalline material having an elastic modulus greater than about 300 gigaPascals at a temperature that does not exceed about 350 °C, with Goesele and Lee I, for example, teaching directly away from anodic bonding at any temperature less than 560 °C.

---

[45] Goesele at column 12, lines 12-15.

[46] *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984), MPEP §2143.01.

IV. Claims 8 and 9 are patentable under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Fukushima

These rejections relate only to dependent claims, which Appellants respectfully submit are patentable in light of the discussions above. None of the references, alone or in combination, teaches or suggests all the limitations of independent claim 1.

In addition, Appellants' dependent claim 8 further recites that the "*RMS surface roughness is greater than 0.01 μm.*" The Examiner argues that "Fukushima establishes the substrate surface roughness as a result effective value in an anodic bonding process," and that "Fukushima exposes a positive relationship between a decrease in the surface roughness and a corresponding increase in quality of an anodically bonded seal for surface roughness values in the range 100nm to 400nm."[47] For the reasons that follow, Appellants respectfully submit that this is incorrect.

Fukushima teaches a method of anodically bonding a glass plate to a cylindrical body consisting of "a metal consisting of at least one of Fe, Ni and Co or an alloy or conductive ceramics mainly composed of this metal."[48] As discussed above, the elastic moduli of iron (Fe), nickel (Ni), and cobalt (Co) are significantly lower than the 300 gigaPascals required by independent claim 1, from which claims 8 and 9 depend, while FIG. 1 of Fukushima shows a relationship between "Quantity of He Permeation" and "Surface Roughness" measured after bonding KOVAR to glass; KOVAR has an elastic modulus of about 159 gigaPascals.[49] As such, the subject matter of Fukushima is directed to methods of anodically bonding completely different materials having structural properties significantly different from those claimed in the present application.

---

[47] Office action of December 11, 2009 at pages 8-9
[48] Fukushima at page 4, lines 24-25.

In addition, Fukushima's FIG. 1, to which the Examiner refers, shows a relationship between Quantity of He Permeation and Surface Roughness measured after bonding KOVAR to glass. Contrary to the Examiner's contention, this figure and the related description[50] are silent on the effect of surface roughness on bonding strength; rather, Fukushima is concerned only with the effect of surface roughness on the quantity of He permeation into the bonded portions after anodic bonding.[51] As such, not only is Fukushima directed toward materials having completely different properties from those claimed herein, but is concerned with a relationship utterly unrelated to the quality of anodic bonding. Accordingly, Fukushima fails to teach or suggest a relationship between a decrease in the surface roughness and a corresponding increase in quality of an anodically bonded seal for a material having an elastic modulus greater than about 300gigaPascals; in fact, the reference fails even to teach or suggest any method of anodically bonding such a material. As such, Appellants respectfully submit that, Fukushima fails to cure the deficiencies of Goesele and Lee I with respect to Appellants' dependent claim 8.

In addition, it is improper to combine references where the references teach away from their combination.[52] Appellants submit that, even if Fukushima could somehow be construed to teach a positive relationship between a decrease in the surface roughness and a corresponding increase in quality of an anodically bonded seal for materials having an elastic modulus greater than about 300gigaPascals, the combination of Fukushima and Lee I would, in fact, teach directly away from anodic bonding using a substrate having an RMS surface roughness greater than 0.01 μm as claimed. More particularly, as Lee I describes a method of bonding a glass to a material having a surface roughness of no more than about 80 Å (i.e., 0.008 μm),[53] the notion that a decrease in the surface roughness would correspond to an increase in quality of an anodically bonded seal would, as applied to Lee I, suggest that a surface roughness of less than 0.008 μm would be preferable — thereby teaching directly away from an RMS surface roughness of greater than 0.01 μm as required by Appellants' dependent claim 8.

---

[49] Fukushima at page 10, line 26 to page 11, line 26.
[50] Id.
[51] Fukushima at page 8, lines 21-24.
[52] *In re Grasselli*, 713 F.2d 731, 743, 218 U.S.P.Q. 769, 779 (Fed. Cir. 1983); MPEP § 2145(X)(D)(2).

V. Claim 12 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Cozma, Lee II, and the ordinary level of skill in the art at the time of the invention, while Claims 13, 14, and 15 under 35 U.S.C. §103(a) are unpatentable over Goesele in view of Lee I and further in view of Wagner, Sarro, Schmidt, and Lee III

These rejections relate only to dependent claims, which Appellants respectfully submit are patentable in light of the discussions above. None of the references, alone or in proper combination, teaches or suggests all the limitations of independent claim 1, from which claims 12-15 depend.

More particularly, Cozma, Lee II, Wagner, Sarro, Schmidt, and Lee III are no more relevant to the claimed invention than Goesele and Lee I. Cozma, Lee II, Wagner, Schmidt, and Lee III are concerned with materials having completely different properties from those claimed in Appellants' present application (e.g., silicon (Si)), while Sarro, like Goesele and Lee I, fail to teach or suggest any arrangement of material layers and electrical contacts for anodic bonding.

---

[53] Lee I at page 202.

CONCLUSION

In view of the arguments above, Appellants submit the Examiner's rejections of claims 1, 3, 5-17, 19, 20, and 24 were erroneous, and urge the Board of Patent Appeals and Interferences to reverse all of the Examiner's rejections as to each of these claims.

Respectfully submitted,

Date: August 11, 2010
Reg. No. 65,640

/W. Gary Dewar/
W. Gary Dewar
Attorney for the Appellants
Goodwin Procter LLP
Exchange Place
Boston, Massachusetts 02109
Goodwin Customer No. 051414

Tel. No.: (617) 570-1582
Fax No.: (617) 523-1231

CLAIMS APPENDIX

1. A method for anodic bonding at least a portion of a MEMS device, the method comprising:

providing a first layer comprising a glass;

providing a first substrate comprising a polycrystalline material having an elastic modulus greater than about 300 gigaPascals;

causing a first surface of the first substrate to have an RMS surface roughness of greater than 0.001 μm and less than about 0.2 μm;

directly contacting the first surface of the first substrate to a surface of the first layer; and

applying a voltage between the first layer and the first substrate, through electrical contacts in direct contact with each of the first layer and the material having an elastic modulus greater than about 300 gigaPascals, to cause an effective anodic bond to form directly between the first layer and the first substrate.

2. (Cancelled)

3. The method of claim 1, wherein the first substrate comprises silicon carbide.

4. (Cancelled)

5. The method of claim 1, wherein the glass comprises at least one of borosilicate glass and aluminosilicate glass.

6. The method of claim 1, wherein the glass is selected from the group consisting of borosilicate glass and aluminosilicate glass.

7. The method of claim 1, further comprising causing the first layer and the first substrate to have a temperature that does not exceed about 350 °C while applying the voltage.

8. The method of claim 1, wherein the RMS surface roughness is greater than 0.01 μm.

9. The method of claim 8, wherein the RMS surface roughness is less than 0.15 μm.

10. The method of claim 1, wherein the RMS surface roughness is less than 0.1 μm.

11. The method of claim 1, wherein the voltage has a value in the range of 200 V to 1000 V.

12. The method of claim 1, further comprising causing the first surface of the first substrate to be hydrophobic.

13. The method of claim 1, further comprising:

providing a second substrate having an elastic modulus greater than about 300 gigaPascals;

causing a surface of the second substrate to have an RMS surface roughness of greater than 0.001 μm and less than 0.15 μm;

contacting the surface of the second substrate to a surface of the first layer; and applying a voltage between the first layer and second substrate to cause an effective anodic bond to form between the first layer and second substrate.

14. The method of claim 13, further comprising thinning the first layer prior to contacting the surfaces of the first layer and second substrate.

15. The method of claim 14, wherein the thinning comprises causing the first layer to have a thickness of less than about 10.0 μm.

16. A device comprising a first layer and a first substrate bonded by the method of claim 1.

17. A method for packaging a MEMS component, the method comprising:

providing a MEMS component comprising a glass layer having a surface and consisting essentially of at least one of a borosilicate glass and an aluminosilicate glass;

providing a device package comprising a material having an elastic modulus greater than about 300 gigaPascals, formed from polycrystalline silicon carbide and having a first surface with an RMS surface roughness of greater than 0.001 μm and less than about 0.2μm;

contacting the first surface of the package to the surface of the glass layer; and

causing the first surface of the package and the glass layer to have a temperature value that does not exceed about 350 ^{o}C while applying a voltage to form an effective bond between the MEMS component and the package, wherein the voltage is applied between the glass layer and the package through electrical contacts in direct contact with each of the glass layer and the material having an elastic modulus greater than about 300 gigaPascals.

18. (Cancelled)

19. The method of claim 1, wherein the first substrate is a device component.

20. The method of claim 1, wherein the first substrate is a device package.

21-23. (Cancelled)

24. A method for anodic bonding at least a portion of a MEMS device, the method comprising:

providing a first layer comprising a glass;

providing a first substrate comprising a material having an elastic modulus greater than about 300 gigaPascals;

causing a first surface of the first substrate to have an RMS surface roughness of greater than 0.001 μm and less than about 0.2 μm;

directly contacting the first surface of the first substrate to a surface of the first layer; and

causing the first layer and the first substrate to have a temperature that does not exceed about 350 °C while applying a voltage between the first layer and the first substrate, through electrical contacts in direct contact with each of the first layer and the material having an elastic modulus greater than about 300 gigaPascals, to cause an effective anodic bond to form directly between the first layer and the first substrate.

EVIDENCE APPENDIX

NONE

RELATED PROCEEDINGS APPENDIX

NONE